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GEOLOGY AND COAL MINING IN THE IPSWICH REGION
A GEOTECHNICAL PERSPECTIVE

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The Ipswich local government area is a rapidly developing regional area of 1200 km^2 with a population of 170,000. The area, which is centred on the city of Ipswich, extends from Springfield in the east to Grandchester in the west and from Karalee in the north to the boundary with Boonah Shire in the south.

The development of Ipswich can be traced back to the discovery of limestone and coal in the 1820s and the navigability of the Bremer River as a transport route between the Brisbane River and the pastoral hinterland. Railway workshops, woollen mills, the Amberley airforce base and other industries have played an important role in the region. The proximity to Brisbane, affordable housing (including about 2000 listed heritage houses), very good medical and education facilities and lifestyle issues have ensured its' ongoing strong growth, as both industrial and residential land becomes scarce in the Brisbane area. The Ipswich City Council, through a number of initiatives including their free on-line internet service on property details (PD online), actively promotes development.

The topography of the study area comprises mainly gently sloping plains and rolling hills whereas more rugged and elevated hills and isolated volcanic peaks exist close to or beyond the perimeter of the study area. Elevations which range from close to sea level to 679m just beyond the study area at Flinders Peak, are more typically in the 20m to 100m A.H.D. range. The topography is a direct result of erosion of the Brisbane and Bremer River catchments on the underlying geological units and their structural discontinuities.

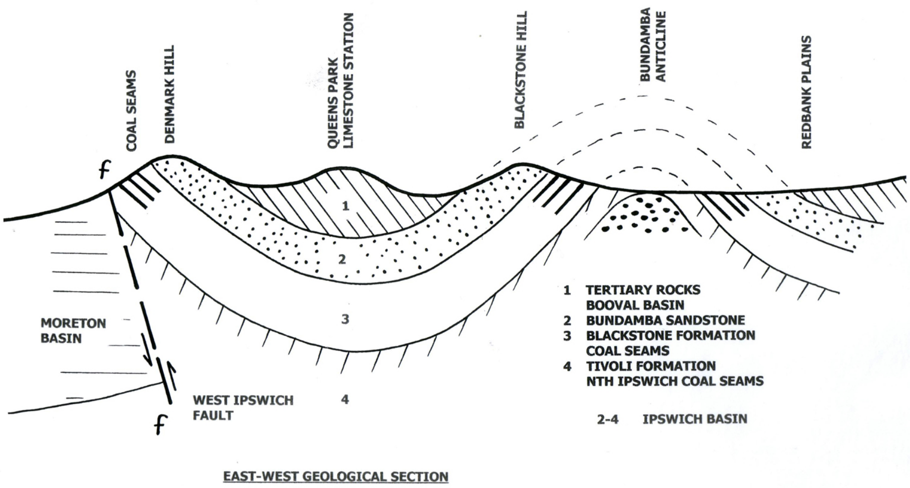


Figure 1

Coal mining in the region was essentially confined to two geological sedimentary basins, i.e. the Ipswich Basin as shown in Figure 1, where the Blackstone and Tivoli Stages of the Ipswich Coal Measures were of past economic importance, and the Moreton Basin where the uncomplicated gently dipping Walloon Coal Measures occur in the Walloon-Rosewood area. Approximately 30 coal seams were of economic importance in both basins.

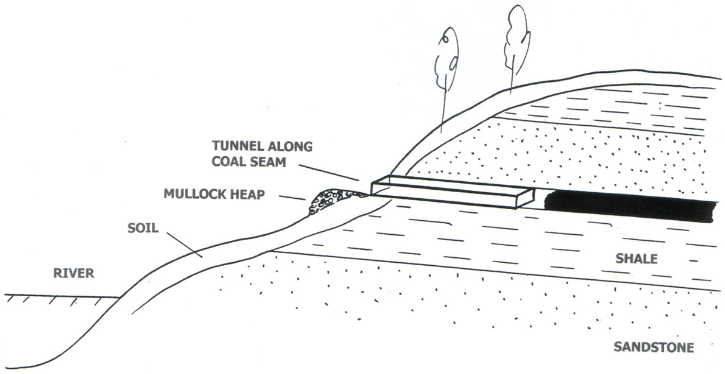


Figure 2

Mining first commenced at Redbank in about 1845 (see Figure 2) whereas the last open cut mine in the Ipswich Coal Measures (Bogside) closed in 2003. Minor open cut mining continues in the Walloon Coal Measures. Underground mines are generally documented post-1900, whereas open cut mines until as late as about the 1980s have been found to be very poorly documented.

Mining (see Figure 3) was initially by underground methods from tunnel and shaft entries, initially using primitive layouts which were followed by Welsh bord and pillar, conventional modern bord and pillar and very locally some variations of longwall mining. Mining ranged between 2.5m and 600m below ground surface, whereas the heights of workings ranged between 1.1m and 12.0m.

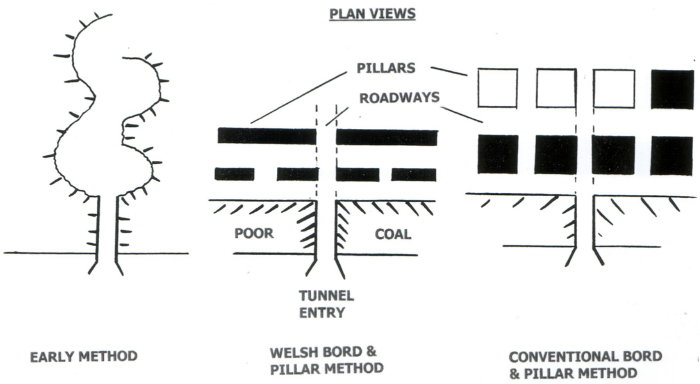
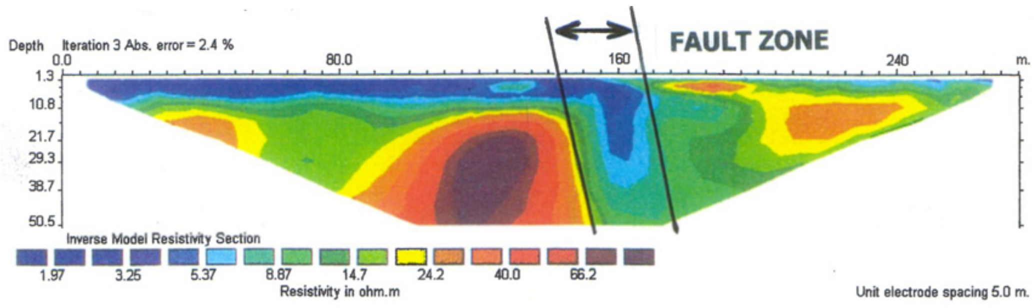


Figure 3

Open cut mining commenced in the 1960s when appropriate earthmoving equipment became available. Open cut mines extracted virgin coal seams as well as pillars left from previous underground mining. Open cut mines extended to a maximum depth of about 105m and maximum lengths of about 1000m. The voids were generally either partially or completely filled with a bulking factor of about 1.3 producing excess spoil which required more space than the formed void, hence the spoil heaps found adjacent to the open cut.

Mining studies aim to establish the base geology and mine geometry as best possible so that assessments can be made on the stability of underground workings, also so that potential surface impacts (maximum subsidence, strain, compressions and maximum ground tilts) can be made. In the case of open cut mines, the locations of buried highwalls need to be located, fill thickness and potential settlements etc need to be assessed with a view to minimising the risk to the particular development.



ELECTRICAL RESISTIVITY TEST SHOWING A FAULT ZONE

Figure 4

Techniques to obtain information include researching available reports, publications, books, geological maps, mine plans etc, drilling, using a down-hole video, carrying out seismic testing (e.g. see fault line from electrical resistivity study in Figure 4), having photogrammetric studies (Figure 5) carried out etc.

Mine plans provide the most useful information if these can be obtained from the Department of Mines, mining companies or other sources. Details on the plans, in the case of underground coal mines, usually include the locations of the tunnel entries and air shaft, the layout of the mine, the type of mining methods (e.g. Welsh bord and pillar) used, whether second workings (floor stripping, pillar splitting or pillar extraction) have taken place, the locations of underground stone drives or staple shafts, as well as the locations of fault lines, problematic areas where fires and creeps have occurred, dates of

workings etc. Unfortunately most plans of underground workings (see Figure 6) do not show the height of workings or the thickness of the workable section. This introduces a number of problems in assessing the stability of the workings. Drilling may be the only way to establish the worked height if it is not mentioned in reports or publications.

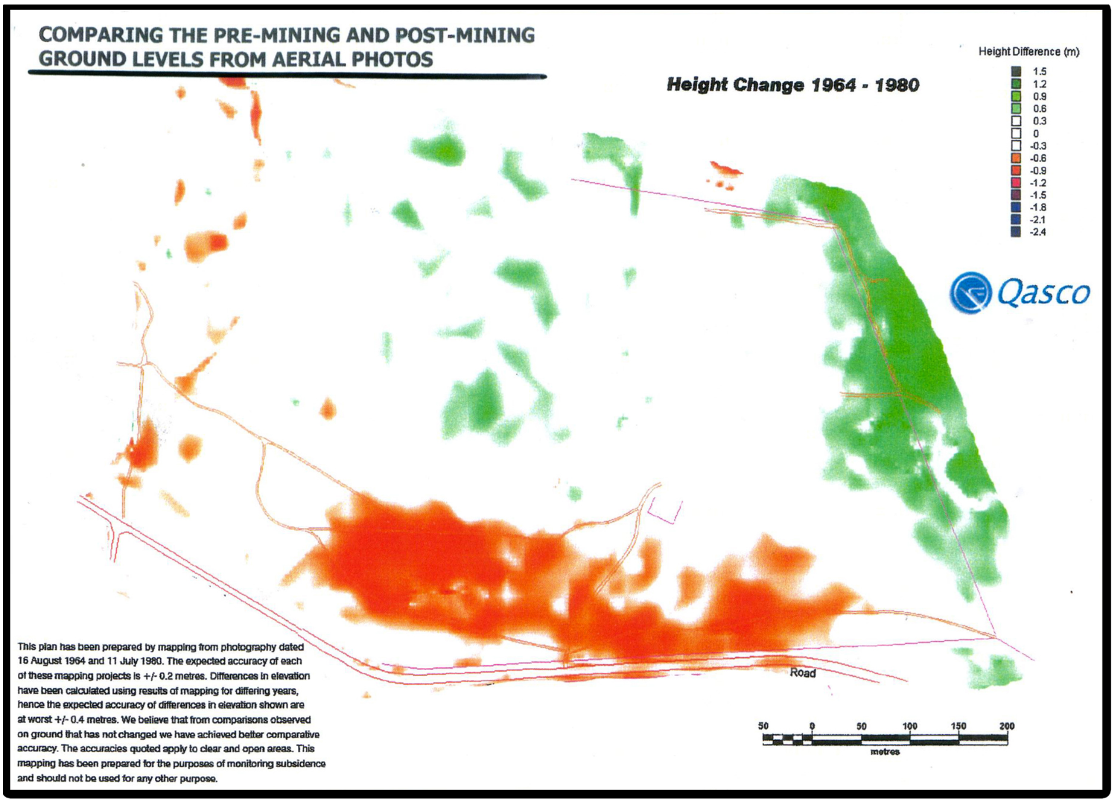


Figure 5

In the case of open cut mine plans, these should ideally show the location of the top of the high and low walls, the extent of coal removal, the position of faults and the natural surface level and the manufactured open cut floor levels prior to any backfilling. Figure 7 is an example of an open cut plan that will not add much to the assessment of this particular site in the future.

The information on mine plans provides a coherent framework in understanding the potential implications for development. For example the stability of remnant underground pillar workings can be calculated by dividing

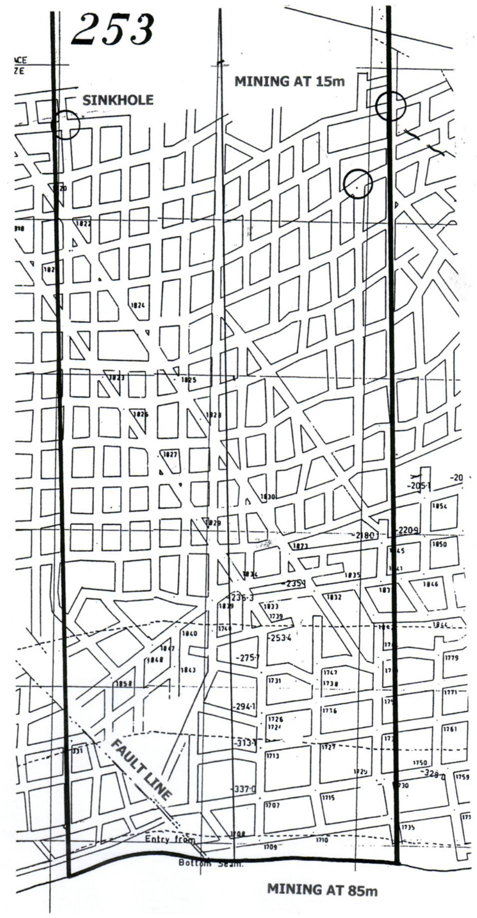


Figure 6

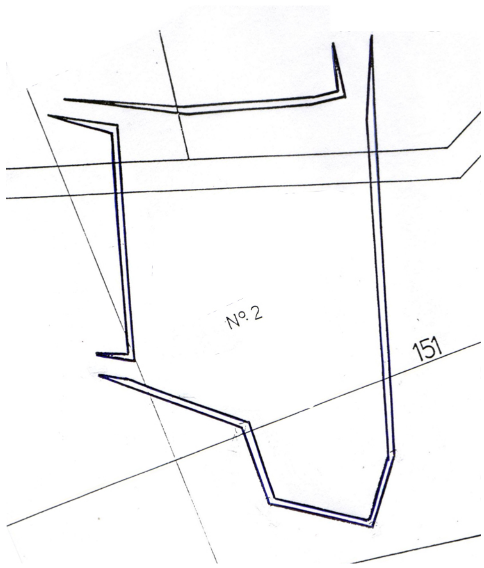


Figure 7

the average pillar strength by the average pillar stress to obtain the factor of safety (FOS) against pillar failure. A FOS of greater than 1.5 indicates probable long term stability whereas a value of less than 1.5 indicates possible future subsidence. A closer assessment of the potential subsidence impacts will then for example determine the suitability of the site for different types of buildings. Knowing the precise location of a buried highwall will for example also reveal the location where sinkholes and maximum differential settlement can occur, i.e. where buildings must definitely not be located. No amount of drilling or detailed studies can provide the same level of information and degree of confidence, associated with development on a site, as a good mine plan.

Two main types of subsidence need to be considered, i.e. sinkhole type subsidence and regional type subsidence. Sinkhole type subsidence is usually the result of the collapse of the intersection of underground roadways at relatively shallow depth which results in void migration to the surface. The sinkholes or potholes which form at the surface can range from stepped shallow depressions to holes of up to 10m in diameter and 10m or more in depth with vertical or overhanging sidewalls. Sinkholes can take up to 50 years or more to reach the surface, however the surface formation is very rapid. The actual or potential formation of sinkholes generally precludes all forms of construction as these hazards usually pose an unaccepted risk to people and structures. Regional type subsidence by comparison results in a more gentle dish type surface feature over a much larger area, i.e. from tens to hundreds of metres across, which can cause structural damage.

Examples of sinkhole activity (see Figures 8 and 9) occurred in Queen Street Dinmore in the years 1971 to 2000 with additional sinkholes possible in the future. Mining under this area had taken place in the early 1960s. The most recent activity resulted in the formation of three large sinkholes to 10m diameter and 4m deep which formed in 1999 and 2000 over 4.5m high workings at 40m depth. The unsupported roof at the intersection of the roadways in the problem area is in the order of 10m to 12m diameter.

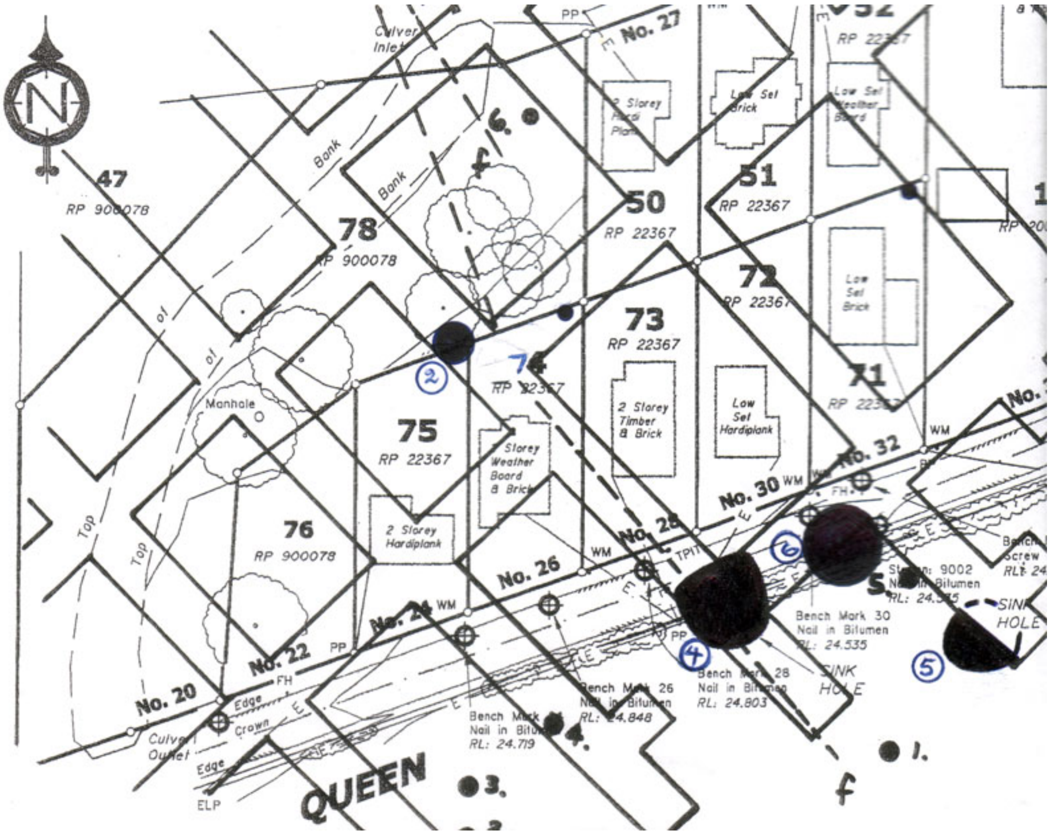


Figure 8

REF. IPSWICH ADVERTISER 21.6.2000

Figure 9

The follow-up study resulted in the removal of seven residences and the sterilisation and permanent fencing off of the area.

Examples of regional subsidence (see Figures 10 and 11) are the recent and 1988 subsidence events at Collingwood Park. The nearby 1988 subsidence area was believed by others (ref 4) to be due to the crushing of 6.0m or more high diamond shaped pillars (between two parallel faults) at about 130m depth. A similar mechanism is also expected to be responsible for the latest subsidence event. Competent sandstone interestingly comprises the bedrock from near the surface to the working level. The 1988 event has so far resulted in maximum subsidence of about 2.1m with maximum ground tilts (rotations) in the order of 1 in 30. The recent event has resulted in at least 1.3m of subsidence which is ongoing at a reducing rate. Thirty three slab on ground houses were affected in the 1988 event, of which about 8 have so far been demolished. The recent event has affected about 20 slab on ground houses, of which about 5 could be demolished. Of note is that if the houses had been of stump type construction then the worst affected houses would probably have required restumping and the rest of the houses relevelling. Buried services would still require repair or replacement.

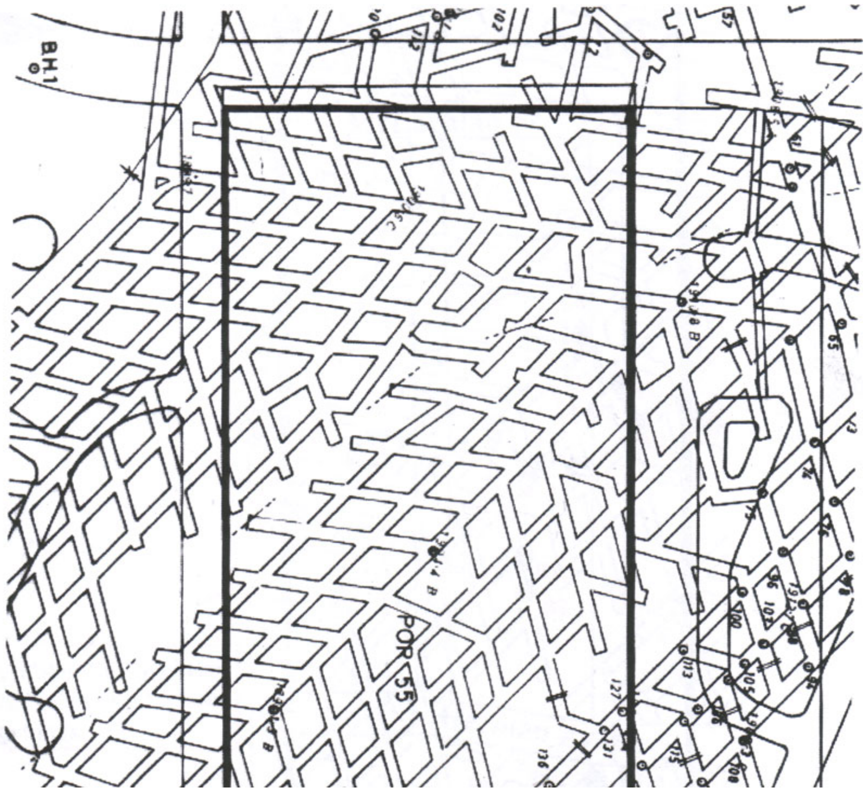


Figure 10

Figure 11

IPSWICH COAL BASIN GEOLOGY - A SIMPLIFIED EXPLANATION

See Figure 1 above.

Think of Moreton Bay. The Pine, Brisbane, Coomera and other rivers continuously pour sediments into the bay. During flood times, layers of heavier gravel are deposited. As the water velocity decreases, then layers of progressively less heavy sand, mud and organics are deposited before the next flood event repeats the cycle. Under increasing pressure, the gravel becomes conglomerate (sometimes referred to as puddingstone), the sand becomes sandstone, the mud becomes shale and the organics becomes coal. Eventually (say 200 million years time) all the rock layers on the mainland side of the bay will dip to the east and the coal seams will only be very thin, because our climate does not support anything like the vegetation in the Jurassic-Triassic period of 135 to 225 million years ago. With increasing pressure, the beds can also deform into folds or 'snap' to form faults where the beds on either side are displaced upwards or downwards.

The oldest rocks of the Palaeozoic period (as old as 600 million years) underlie all the basins and intervening formations. Those rocks are metamorphic, i.e. previous sedimentary rocks that have been altered under great heat and pressure.

Youngest Tertiary basins (60 million years) overlie the Ipswich and Moreton basin. The rocks in these basins include sedimentary rocks (weak shales, siltstones and sandstone but no coal) as well as volcanic rocks (basalt) e.g. from Mt Warning and other surrounding volcanoes such as Mt Flinders.

Some references

1 "Coal in Queensland, The First Fifty Years" by R.L. Whitmore, 1981
2 "Coal in Queensland, The Late Nineteenth Century" by R.L. Whitmore, 1985
3 "Coal in Queensland, From Federation to the Twenties" by R.L. Whitmore, 1991
4 "Mining Subsidence of an Urban Area in Ipswich Queensland" by Maconochie, Wardle and Wright in "11th International Conference on Ground Control in Mining", University of Wollongong NSW, July 1992.